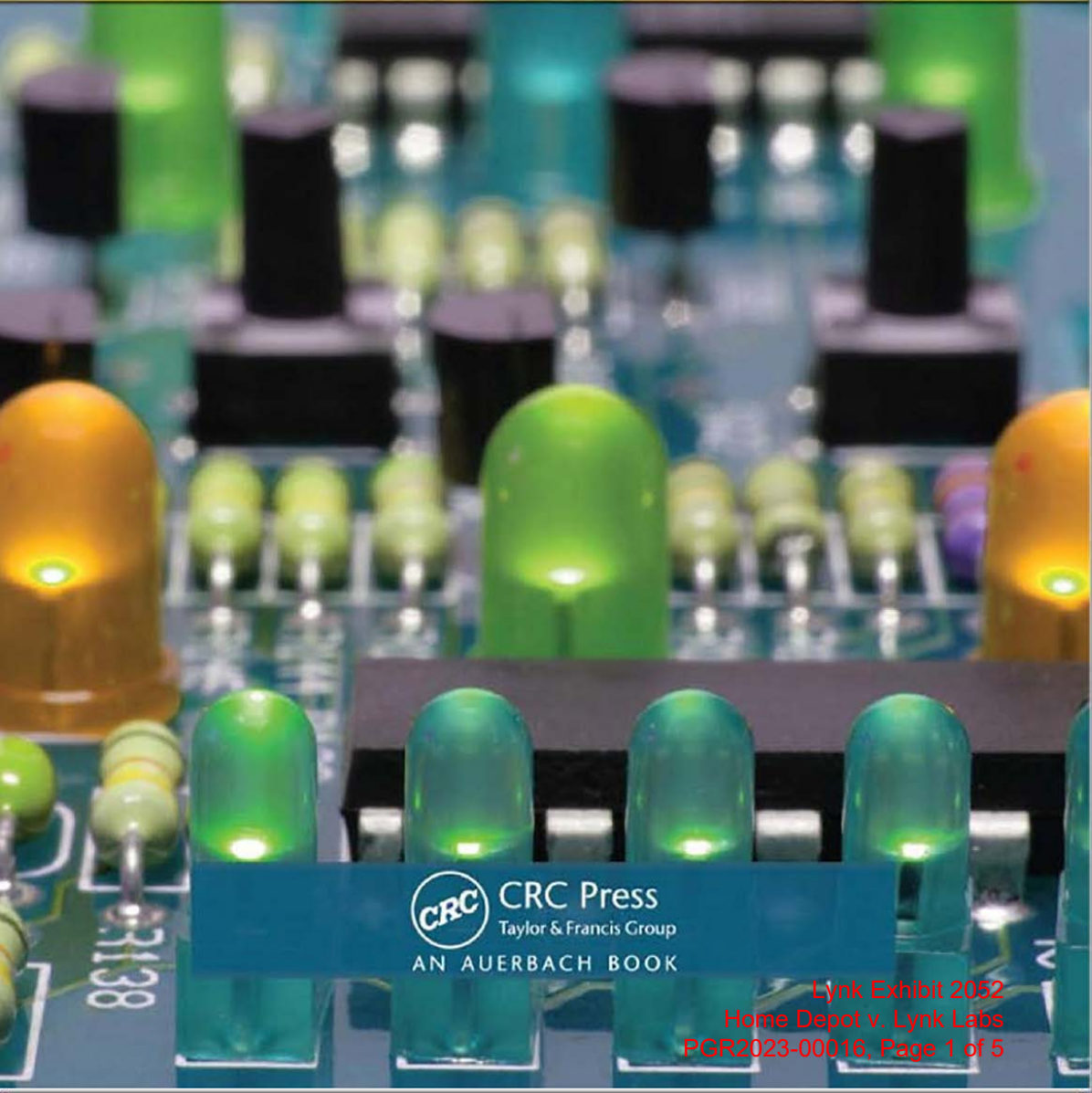


Introduction to Light Emitting Diode Technology and Applications

GILBERT HELD



CRC Press

Taylor & Francis Group

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3.4.1 Rationale for Use

Previously in this book, we noted that LEDs are current-driven devices. As the current increases, the brightness of the LED increases. Thus, its brightness is proportional to the forward current.

There are essentially two methods that can be used to control the forward current flowing through an LED. The first method involves the use of the LED's voltage-current curve to determine the level of voltage required to generate the desired forward current. In fact, in Chapter 1 of this book, we examined how this was accomplished by using a resistor and Ohms law to determine the current that would flow through an LED.

That is,

$$I = \frac{V_s - V_f}{R}$$

where

V_s = voltage at source

V_f = forward voltage

R = resistance

Although it's common to use a resistor in simple LED applications, for more sophisticated applications there are several drawbacks to this method. First, any change in the LED forward voltage will create a change in the LED current. Thus, a slight voltage change that is within a specified voltage tolerance due to temperature or manufacturing changes can result in a forward current change. For example, consider the circuit shown in Figure 3.9 in which a 6 V battery and 120 Ω resistor are used to drive an LED that has a forward voltage of

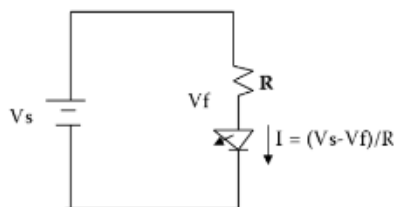


Figure 3.9 The use of a resistor to limit forward current.

3.6 V, resulting in a forward current of 20 mA. Suppose the voltage changes to 3.8 V. Then, the forward current will become

$$I = \frac{6 - 3.8}{120} = 18.33 \text{ mA}$$

Thus, an approximate 5.7 percent $((3.8 - 3.6)/3.8)$ change in the forward voltage results in a 8.5 percent $((20 - 18.33)/20)$ change in the forward current. Thus, a change in the forward voltage can result in a larger percentage change in the forward current. This can result in an LED burn or a significant reduction in the half-life of the device, depending on the change in the forward voltage.

A second method used to regulate LED current is obtained by driving the device with a constant current source. Through the use of control circuitry, a constant current source is provided or “driven” to the LED. This constant current eliminates variations in current due to changes in the forward current, which results in a uniform or constant level of LED brightness. Thus, driving an LED with a constant current is a better method of regulating LED current.

3.4.2 Using PWM

If we take the use of driver circuitry a bit further, we can obtain an understanding of how LEDs can blink and change their level of brightness. To do so, the driver circuit can provide a pulsing current, in effect use pulse width modulation (PWM), with different duty cycles of the current waveform to transition the LED between its ON and OFF states; the time spent between and in each of the two states provides the impression that the LED is being dimmed, in a flashing mode, or being both dimmed and in a flashing mode of operation.

The rationale for using PWM instead of regulating the amount of current is how many LEDs react to a low current. Although the light output of an LED is proportional to drive current over most of the LED’s current range, as the current level significantly decreases, the device can either flicker or change color. Thus, although both methods (PWM and regulating the drive current) can be used to adjust LED brightness, PWM provides the ability to pulse an LED as well as is the preferred method for dimming LEDs. Now that we have